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Immediate Response to Free Product Discovery

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Abstract: Underground storage of petroleum products such as gasoline, diesel oil, fuel oil,
and aviation fuel can be a significant source of contamination of ground water and soil. Estimates by the Environmental Protection Agency (EPA) indicate that nearly 25% of all steel underground storage tanks (UST) are leaking. The need to initiate remedial measures as soon as leaking is detected is of paramount importance. For any migrating fuel plume problem, the first priority must be to gain control of the migrating product to prevent further soil and ground water contamination. Proper immediate response can significantly reduce the ultimate cleanup cost, increase the efficiency of the cleanup, and mitigate further environmental damage.

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Introduction

Underground storage of petroleum products such as gasoline, diesel oil, fuel oil, and aviation fuel can be a significant source of contamination of ground water and soil. Estimates by the Environmental Protection Agency (EPA) indicate that nearly 25% of all steel underground storage tanks (UST) are leaking (1). The need to initiate remedial measures as soon as leaking is detected is of paramount importance. For any migrating fuel plume problem, the first priority must be to gain control of the migrating product to prevent further soil and ground water contamination. Proper immediate response can significantly reduce the ultimate cleanup cost, increase the efficiency of the cleanup, and mitigate further environmental damage.

Purpose and Audience

The purpose of this Tech Data Sheet is to:

- Help plan for response to discovery of free product during UST or other construction activities, which will facilitate future remedial actions and reduce their costs while ensuring regulatory compliance;
- Introduce Project Superintendents, Engineers in Charge, and On-Scene Coordinators to regulatory issues, engineering and hydrogeologic processes, and available remedial technologies; and
- Help Navy Engineering Field Division (EFD) personnel structure contracts and develop scopes of work (SOW) for free product remediation projects, and assist Remedial Project Managers (RPMs) with review of project plans and actions.

Description of the Problem

Petroleum releases from UST are a significant source of contamination to ground water and soil. Releases can originate in the tanks themselves or in supporting piping systems. Subsurface releases can go undetected for relatively long periods of time because the release is below the surface and is not directly observed. While state and federal regulations now require tank owners to have a monitoring system in place to detect releases of petroleum, the regulations do not cover all tanks and have only been in effect for a short period of time. Furthermore, some monitoring systems (inventory reconciliation for example) may not have the ability to detect small releases. Even a relatively small leak, over a period of time, will allow free petroleum product to collect in the ground and come in contact with ground water, given the right conditions.

The potential for accumulation of liquid phase product that is free to move by gravity above the water table is dependent on several factors including:

- Physical and chemical properties of the product released (e.g., viscosity, density, composition, and solubility in water);
- Soil properties (e.g., porosity, moisture content, clay content, hydraulic conductivity, capillary forces, and grain size distribution);
- Nature of the release (e.g., initial date of occurrence, duration, volume, and rate);
- Geology (e.g., stratigraphy that promotes trapped pockets of free product); and
- Hydrogeologic regime (e.g., depth to water table, ground water flow direction, and gradient).

Free product (see "Terminology") can accumulate under a very wide variety of conditions. In general, however, free product is more likely to accumulate in instances where:

- The soil has properties that reduce soil suction (e.g., higher moisture content and larger effective pore radius);
- The petroleum product consists of mostly low density and low solubility components; and
- The ground water is shallow with a relatively low hydraulic gradient.

Free product is often detected directly during UST removals, UST upgrades and investigations, incident response investigations and other activities such as underground utility repair, monitoring well installation, new construction, and demolition. Presence of free product is generally suspected when strong petroleum odors are detected in basements and below-ground structures in areas away from suspected sources.

Potential threats to health, safety, and the environment imposed by the presence of free product include:

- Fire and explosions;
- Exposure to toxic vapors; and
- Damage to surface and ground water drinking water sources and natural habitats.

Terminology

Petroleum products can be contained in the subsurface in several ways. The following terms are commonly used to describe the presence of product:

Free product: Petroleum-based products occurring in the subsurface when the hydraulic pressure of fluid in the ground meets or exceeds ambient soil vapor pressure (one atmosphere). The product is thus "free" to flow in response to gravity.

Floating product: Petroleum-based products having significant fractions of lighter-than-water compounds (e.g., gasoline, diesel fuel, #2 or #4 heating oil, aviation fuel, waste oil, kerosene, lubricating oils) that have accumulated on the water in a well or cavity. Products floating on the water in a well bore are not indicative of the actual conditions in the surrounding subsurface environment. The term "floating" is inadequate to describe fluid processes in the subsurface and should not be used in that context. In addition, the relative amount of product found floating in well bores cannot be used as a direct indicator of the amount of free product available for recovery from wells by gravity methods.

Product can range from a sheen or thin film to an accumulation of pure product several feet thick. The observed thickness of product in a well is generally greater than the actual thickness of free product in the ground, by factors ranging from 2 to 24 (2). Product thickness in the ground is related to many factors—especially grain size distribution (3).

Residual product: Refers to product present in the following forms:

- Liquid product contained in soil pores either bound or migrating in response to capillary forces. This *capillary product* is present at pressures below one atmosphere and will not flow by gravity;
- *Vapor phase* petroleum hydrocarbons contained in soil void space;
- *Dissolved phase* petroleum hydrocarbons in soil moisture and ground water;
- *Solid phase* petroleum hydrocarbons bound by molecular forces to soil particles; and
- *Suspensions, emulsions,* and *droplets* of petroleum hydrocarbons within subsurface waters.

Other terms used throughout this Tech Data Sheet include:

Hand bailing: Retrieval of fluid from a well using a bailer (Figure 1a). The bailer is lowered into the well on a rope and allowed to fill from the bottom.

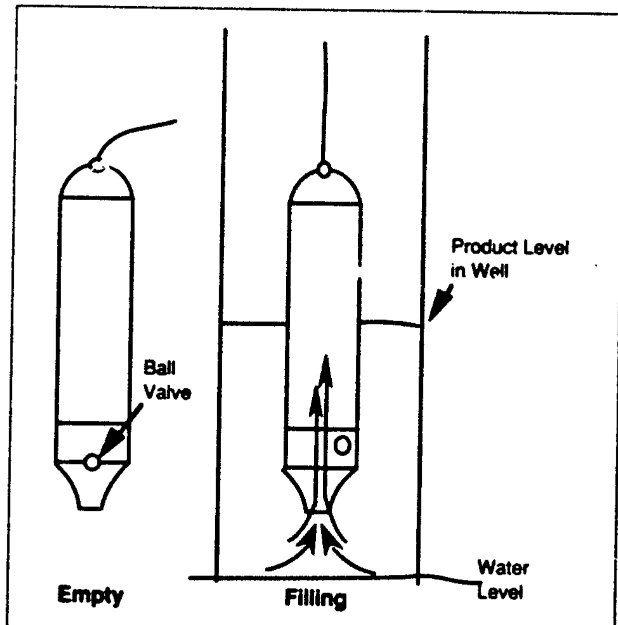

Figure 1a. Hand Bailer (not to scale)

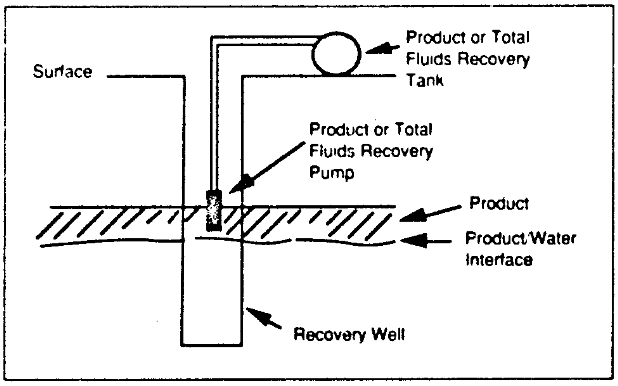

Figure 1b. Skimmer Pump System (not to scale)

Skimmer: A free product removal device used in wells and open pits (Figure 1b). The skimmer is a pump positioned at the oil/water interface to extract product from the water surface. Some skimmers are designed to collect only oil by using hydrophobic filters. Others collect all lower density fluids above the water table.

Dual pumping: A petroleum recovery system in which water in a well is drawn down by pumping to depress the water table and create a high ground water gradient near the well (Figure 1c). A second pump is placed at the top of the water column in the well to collect free product which has accumulated due to gravity.

Stinger truck: Liquid vacuum truck capable of sucking up any liquid including free product and water.

Interceptor trenches: Trenches placed into the water table in the path of ground water flow allowing extraction of contaminated fluids. Free product can then be removed from the collected fluids.

Sparging: A remedial technique in which air is passed (bubbled) through ground water to enhance volatilization and biodegradation of organic contaminants dissolved in the ground water. Volatilized contaminants are generally carried to the ground surface by vapor extraction methods for treatment.

Importance of Rapid Response to Free Product

Using the ARMOS (Areal Multiphase Organic Simulator) model for free product migration and recovery, response times and cleanup efficiencies were analyzed (4). The results, as shown in Figure 2, illustrate the importance of rapid response to free product discovery.

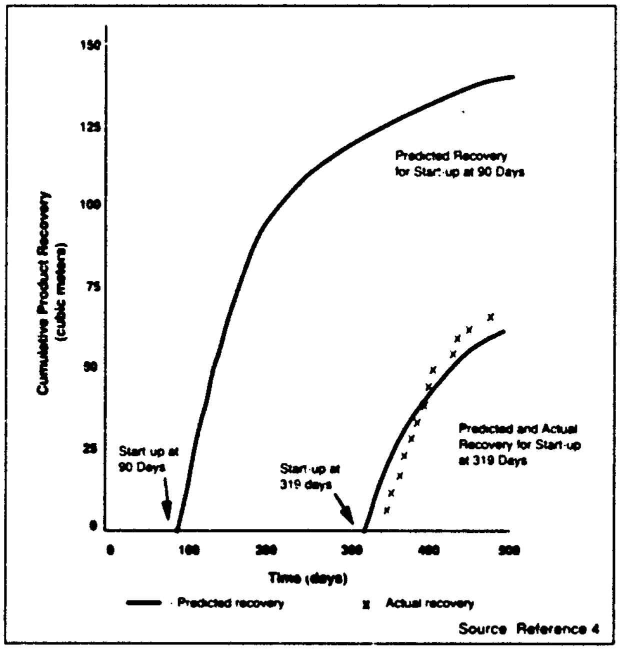

Figure 2. Effects of Start-up Time on Recovery

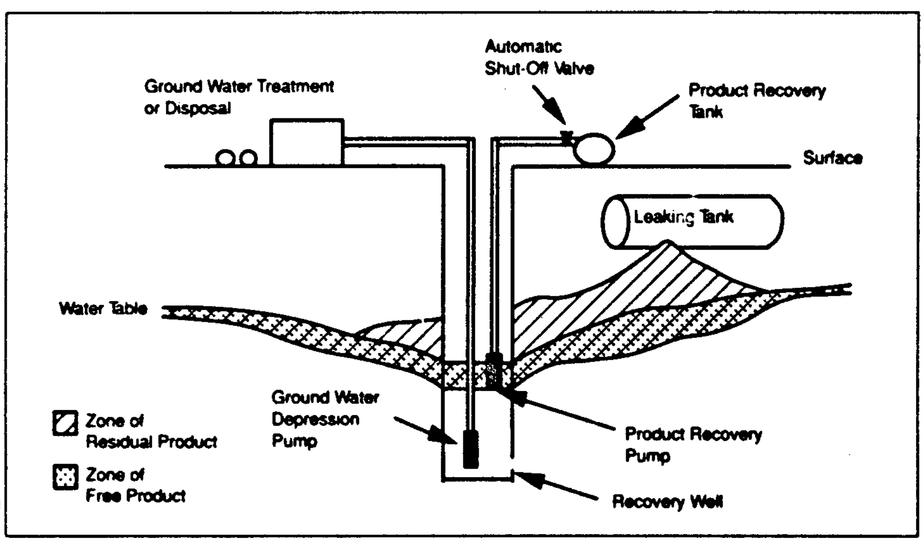

Figure 1c. Dual Pump System (not to scale)

Input to the model included the following actual spill site data:

- Spill volume of 300 cubic meters;
- Redistribution of spill under natural gradient from 0 to 319 days;
- Ground water pumping and oil skimming beginning at day 319 and continuing until day 478; and
- Site-specific soil, product, and hydrogeological properties.

Important results of the model show that if response were initiated after 90 days, by the end of one year nearly 50 percent of the total spill volume would be recovered under the given conditions. In contrast, if response were not initiated until 319 days, the recovery total would begin to level off to approximately 20 percent of the spill volume. This latter observation has been confirmed by actual recovery data obtained in the field.

This model illustrates that the maximum recovery can be achieved by beginning the recovery response as soon as possible after the discovery of free product. The longer one takes to initiate recovery, the more opportunity the plume has to spread. As it spreads, it comes into contact with more and more soil or sediment, thereby rendering more product "tied up" as residual (see "Terminology").

Product lost to residual is no longer available for recovery as pure product but may be present as solid, vapor, or liquid phase contamination in ground water or soil. Remediation of contaminated ground water and soil is generally more expensive than free product recovery. In addition, ground water and soil remediation can take on the order of years (if ever) to reach regulatory cleanup levels. This is in contrast to recovery of free product, which can take on the order of weeks to months to complete.

Failure to react immediately to the identification of free product may result in the need to perform investigation and cleanup efforts over a larger area, as well as requiring additional efforts to treat contaminated ground water and soil. In summary, delays in action increase:

- Environmental, health, and safety risks;
- Overall complexity and time of cleanup; and
- Cost to the Navy.

Approach to Free Product Discovery and Response

An immediate response approach is frequently taken by the private sector and supported by the Environmental Protection Agency (see "Regulatory Issues"). With this approach, mitigation procedures begin immediately upon detection of free product. Effective immediate response can be initiated prior to and during a full site assessment while conforming to EPA policy and maintaining common sense. Interim remedial actions can address contamination as it is discovered. The interface of interim actions with the corrective action is illustrated in Figure 3. It should be noted that specific state or local regulations may impact the course of these actions.

Too often, immediate or interim response measures are not taken to mitigate free product. For example, if free product is found during UST removal or monitoring well installation, the project may be placed on hold to allow for:

- Regulator notification;
- Regulatory approval to take action;
- Preparation and approval of site assessment plan;
- Full site assessment and characterization; and
- Preparation and approval of Corrective Action Plan.

By following this course of action, cleanups may unncecessarily take several years to complete—or may never be completed.

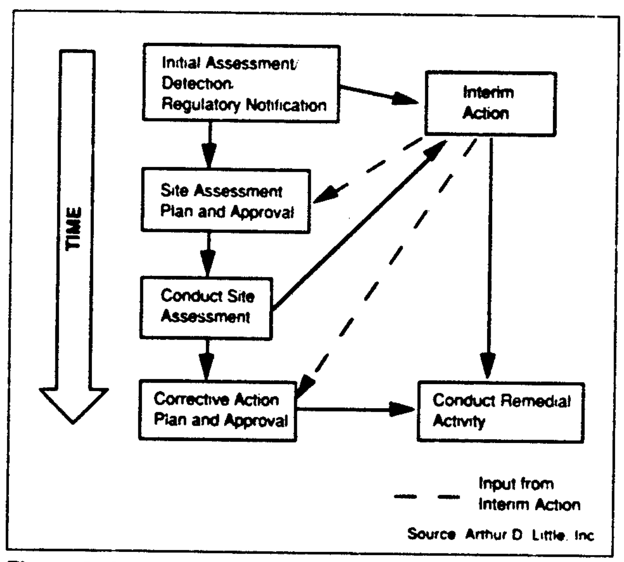

Figure 3. Appoach to Corrective Action

Planning and Response Strategies

Time and resources can be saved by adequate prevention and response planning. This planning should be oriented toward providing the maximum capability for immediate spill response.

One of the primary goals of immediate response is to prevent the spread of the contaminant plume, thus minimizing the potential for increased soil contamination. The greater the extent of soil contamination, the greater the cost and time to remediate. To achieve this goal, the following elements should be key in remedial planning:

- Anticipation of the discovery of free product;
- Knowledge of the actions to be taken upon detection of free product; and
- Immediate implementation of interim remedial action concurrent with regulatory notification.

In general, planning strategies prior to initiating any UST actions should include:

- Ensuring the installation of state-of-the-art leak detectors and alarm systems in new installations or upgrades;
- Educating those responsible for immediate response in procedures and equipment;
- Developing an understanding of the potential for the release and spread of product (based on tank and piping age and history, nature of release, proximity to release, depth to ground water, etc.);
- Establishing actions if product is discovered (including recovery methods and goals, regulatory interaction, and schedules); and
- Developing contingency plans for modification of original project plans after product recovery goals are met.

An additional important feature of planning strategies is notification of appropriate emergency response and construction personnel. If product is discovered, the Resident Officer in Charge of Construction (ROICC) and the Public Works Center (PWC) should be notified immediately. These personnel will ensure that no construction is to be performed in the affected area that could endanger the health and safety of workers or jeopardize environmental remediation activities.

Not all UST investigations and removals warrant the presence of immediate response equipment and personnel; however, advance planning and preparation will help in those situations that require immediate response support to minimize contaminant migration.

For example, if one discovers product while placing a well or boring around an UST under investigation, it would be wise to utilize a stinger truck service during future tank-pulling operations. Typically, a stinger truck should be either placed on standby or available on-site during UST removal and during investigations to remove free product upon discovery. Booms and sorbent pads should be readily available at locations where ground water is likely to be observed in pits or trenches.

Contractual mechanisms should be available to provide immediate response to the discovery of free product. These include:

- Emergency response contracts (established at the EFD level) with local response contractors for petroleum extraction so that actions can be taken immediately with minimum lag time; and
- Contracts with stinger truck services and waste disposal firms established so that trucks can be on-site for each situation in which investigators or workers may encounter free product.

The implementation of proper planning and response strategies will increase the potential for:

- Cost reductions of future remedial actions associated with the site;
- Remedial efficiency; and
- Facilitation of future site characterization and remediation efforts.

Regulatory Issues

Specific regulatory considerations regarding free product detection, response, and recovery relating to UST systems are established under the Resource Conservation and Recovery Act (RCRA). Resulting regulations are published in 40 CFR 280.60 through 280.65. The requirements set forth in these regulations include those actions associated with:

- Initial response (including notification of the implementing regulatory agency) (40 CFR 280.61);
- Initial abatement measures and site assessments and characterization (40 CFR 280.62 and 63);

- Free product removal (40 CFR 280.64); and
- Investigation for soil and ground water cleanup (40 CFR 280.65).

These regulations emphasize the need for immediate response to prevent further release of the regulated substance into the environment. They encourage initiating free product removal as soon as feasible after detection.

As specified in 40 CFR 280.64, free product removal must be conducted so as to minimize the spread of contamination. Techniques selected for the removal or recovery of product must be appropriate to the hydrogeologic conditions at the site. All recovery by-products must be managed in compliance with applicable local, state, and federal regulations. Within 45 days after confirming a release, a free product removal report must be prepared and submitted to the implementing regulatory agency.

These requirements may be supplemented by state and/or local regulations. Federal regulators have attempted to maintain a decentralized posture with respect to UST actions concerning notification, review, and inspection. These activities are carried out on the state or local level to the maximum extent possible (5).

State regulations or policy may affect the response to product discovery. States may require total characterization prior to extraction of product. In some cases, this may not be practical. However, state regulatory issues or policy must be recognized.

In product recovery operations, required permits may include:

- Water permits (for treatment and/or discharge); and
- Air permits (in the event that recovery or water treatment processes create potential sources of emissions).

Product Recovery Techniques

A summary of the applications and limitations of common free product recovery techniques is presented in Figure 4. In addition, relative magnitudes of the levels of sophistication and costs of the techniques are presented.

Technique	Relative Degree of Sophistication	Relative Cost	Advantages	Limitations/ Disadvantages
Booms/Sorbents	Low	Low	Can be employed immediately upon spill detection.	Temporary measure only. Limited to use in open pits or trenches.
Single Phase Extraction (hand bailing, hand pumping)	Low	Low	Important information regarding recovery potential is learned. Can be quickly implemented during UST removals or upon detection of product in wells.	Slow and labor intensive process. Personnel safety equipment required. Ability to remove a significant amount of floating product is limited. Water separation and disposal may be required.
Single Phase Extraction (vacuum pumping, skimming)	Med	Low to Med	Can be employed immediately on product detection. Can be used to remove floating product during UST removals or from wells.	Equipment purchase or rental required. Ability to remove all floating product is limited. Water separation and disposal may be required.
Dual Pump Systems	Med to High	Low to High	Very effective in floating product removal. Useful for long term water treatment.	Water treatment is required. Permits for water treatment may be required thereby adding to response time.
Interceptor Trenches (French Drain)	Low	Med to High	Suitable for long-term product recovery. Capable of collecting large volumes of product.	Long-term action. Not suitable for immediate response if design must be approved by regulators.

Figure 4. Applications and Limitations of Common Recovery Techniques

Source NEESA and Arthur D. Little, Inc

Factors to be considered in selecting a particular technology for recovery of free product include:

- The magnitude of the problem;
- Potential impacts of the problem; and
- The nature of the problem.

For example, if large amounts of free product are detected during a tank excavation, a stinger truck can be used to remove the product immediately, and an interceptor trench (French Drain) can be installed for longer term recovery operations.

If tank removals or investigations are performed in areas of standing water, precautionary sorbent booms should be in place to minimize migration of contaminants. If free product is visible in standing water as well as in open pits or trenches, frequent sweeps of the sorbent booms may be appropriate for recovery.

For immediate response, hand bailing or hand pumping can usually be quickly implemented to remove product from a monitoring or extraction well. These techniques may also be useful to determine recharge rates for each well. Increasingly sophisticated techniques such as skimming and dual pumping can be used to increase product removal efficiencies and for longer term recoveries of larger amounts of product.

If recharge of product to the well is slow, use of a hydrophobic oil-selective skimmer may be beneficial. A dual pump system may be required if the estimated product recharge rate is high or the extent of the problem is large.

Free product recovery methods are often limited by the minimum thickness of the product they will recover. Most recovery techniques can remove product to a thickness of less than one-quarter inch without removing water. In order to recover the additional film of free product, some water will need to be removed as well.

Once free product is removed, attention must be paid to the possible presence of residual contaminants. If recovery of residual product is necessary, additional techniques must be employed adding to the overall time and cost required for recovery (see "Interfacing Technologies"). It should be reemphasized at this point that the problems associated with residual product recovery are minimized by an immediate initial response to free product discovery.

Implementation Considerations

Once free product is detected, immediate response should include both removal of the source and recovery of available product by the most expedient means. The use of stinger trucks is expedient; however, these trucks generally do not distinguish product from water and, therefore, the cost of disposal (or recovery) of the free product will increase according to how much water is extracted along with it.

Free product recovery methods will often recover contaminated water with the product. If economically desirable, water and product can be separated by gravity prior to disposal or recycling of the product.

Due to the removal of substantial quantities of water during dual pumping operations, on-site water treatment will normally be required. A typical treatment system may include an initial separation of water and product by gravity (e.g., using an oil/water separator), followed by activated carbon adsorption or air stripping of the water phase.

When treatment of recovered water is required, permits will usually be necessary. These permits will dictate the final disposition of the treated water. Completing permit applications and obtaining approvals may add up to six months to the time required to implement recovery techniques such as dual pumping. For this reason, interim techniques such as single phase extraction will usually be employed as an initial response while concurrently applying for necessary permits.

Most military installations have discharge permits in place for water-using activities. When a contamination problem is discovered, it is advisable to start modifying these permits immediately to accommodate discharge of treated water.

Residuals Generated

Residuals generated from free product recoveries include the product and various amounts of contaminated water. Typically, service contracts with hazardous waste disposal contractors are established to dispose of or recycle recovered product.

Additional residuals may be generated during the treatment of contaminated water resulting from product recoveries. Common treatment residuals include spent activated carbon. This spent carbon may be disposed of or regenerated depending on economics.

Interfacing Technologies

When gathering data during early response and treatment efforts, it is important to recognize the differences between control, treatment, and characterization issues and priorities.

For any migrating fuel plume problem, the first priority goal must be to gain *control* of the migrating product to prevent further soil and ground water contamination.

Treatment of contaminated soil and ground water, while important, must be secondary to control. As control measures are implemented, data must be gathered to identify further control needs and to help select treatment alternatives.

After control measures have been implemented, a full *characterization* of the soil and ground water phases, flow dynamics, and volumes is needed in order to assure complete cleanup.

In this integrated approach, multiple technologies may be interfaced in order to optimize the efficiency and cost of plume control, contaminated media treatment, and ultimate cleanup.

Interfacing remedial technologies available for soil and ground water contaminated with petroleum products include:

- Bioremediation (e.g., naturally aerated, heap pile, or composting—all of which are described in NEESA Tech Data Sheets);
- Soil washing (solvent applications);
- Soil vapor extraction;
- Air sparging (see "Terminology");
- Thermal treatment (e.g., incineration or low temperature thermal desorption); and
- Steam injection.

Product dissolved in ground water may be removed using traditional pump and treat techniques. The most common techniques used are carbon adsorption and air stripping. Both technologies are proven and each has advantages and disadvantages. Carbon adsorption is effective and easy to accomplish; however, the management (regeneration or disposal) of the spent carbon may be a consideration with respect to cost. Air stripping, applicable for volatile contaminants only, may be similarly effective but may generate a contaminated gaseous effluent requiring further control (by carbon adsorption or catalytic oxidation, for example) and/or permitting. Regardless of the technology selected, separation of oil and water after pumping and prior to treatment may be desirable.

A more advanced recovery technique has recently been developed employing a thermal vacuum spray aeration process. This technique is a combination of pump and treat and soil vapor extraction technologies. In this process, a vacuum is placed on the well to extract product vapors from soil, and a pump is installed in the well to extract contaminated ground water. The well is screened above the water table for a sufficient length to ensure effective soil vapor extraction. The extracted water is sprayed into a heated chamber that is also under vacuum. The combination of vacuum and higher than ambient temperature in this chamber enhances the removal of volatile organic contaminants from ground water. This organic-laden stream and the vapors extracted from the well are then thermally oxidized in an internal combustion engine. The engine also drives the vacuum pump for soil vapor extraction and can provide compressed air for pumping ground water from the extraction well. Ideally, the organic contaminants provide sufficient fuel to sustain the engine for thermal oxidation of organic vapors.

The Navy owns one of these multi-phase contaminant removal systems. This system may become available for use by those in need at the installation level (4).

Cost Considerations

Key cost factors for the recovery of free product include:

- Waste disposal (e.g., product, water, sorbent pads, soil);
- Potential for sale of recovered product for recycling;
- On-site equipment rental (stinger trucks, pumps, tanks, treatment systems);
- Installation of permanent equipment (including wells and trenches);
- Engineering and testing costs;
- Operation and maintenance costs (sampling and analyses, activated carbon use, labor, power); and
- Permit application preparation and approval.

Because of the number of variables involved, establishing general costs for free product response is difficult. Some representative costs have been identified based on Navy experience (Figure 5). These costs illustrate the relative magnitudes of the various recovery options available.

It should be emphasized that delays in response can cause costs to increase dramatically. In effective immediate response actions, costs may be limited to those incurred by using simple

Recovery Technique	Estimated Cost ($ month)*	Included in Cost
Single Phase Extraction (Hand bailing)	$500	Bailer, personnel protection equipment, facility report preparation and review, operation and maintenance, product storage
Single Phase Extraction (Skimming)	$1200 to $2000	Equipment rental, operation and maintenance, facility report preparation and review, product storage
Dual Pumping	$2500 to $4000	Recovery and water treatment equipment rental, operation and maintenance, facility report preparation and review, product storage, and permitting.

*Estimated costs are based on use of single recovery system (i.e., one bailer, one skimmer, and one dual pumping system)

Source: NEESA and Arthur D. Little, Inc.

Figure 5. Representative Free Product Recovery Costs

free product recovery methods such as hand bailing and skimming. However, with the progression of time and the resulting loss of recoverable product to residual or migration, costs are likely to increase by orders of magnitude due to:

- Need to remove product over a wider area;
- Employment of more rigorous methods of product recovery;
- Use of pump and treat ground water treatment technologies;
- Soil excavation and cleanup; and
- Additional regulatory interaction, approval, and permitting.

Application Examples

The case studies described below relate the above discussion to real-world experiences.

Case Study 1. Navy Gasoline Station Located in Coastal Area

During an UST investigation in 1986, floating product greater than 0.25 ft in thickness was detected. Regulators were contacted and Navy personnel were instructed to complete a site characterization including construction of monitoring wells. No interim action to remove the floating product was initiated.

Three years after the discovery of the floating product, weekly hand bailing of the wells was initiated. It was observed during hand bailing operations that a few of the wells had relatively rapid product reinfiltration.

Several weeks after initiating hand bailing, skimmer pumps were used for the recovery of floating product in those wells with rapid reinfiltration. After two months of skimming, the more rigorous method of dual pump extraction was employed.

Because of the lag in initiating action, advanced extraction techniques (dual pumping) had to be employed at this site. The spread of contamination over time required the installation of 12 additional monitoring wells bringing the total on-site to 35. Both of these requirements resulted in increased time to treat and increased cost.

Additional results of the lag between discovery and action are the dissolution of product into the ground water and contamination of additional vadose zone soils.

To extract the dissolved hydrocarbons from the water, a thermal vacuum spray aeration system (see "Interfacing Technologies") is being used to treat contaminated ground water at a rate of 60 gallons per minute. Soil vapor extraction will be employed to mitigate contaminated soil.

Lessons learned as a result of this experience include:

- Response lag time of over three years was due to the absence of an interim remedial plan; and
- Cost and time increases were, and continue to be, experienced due to the response lag time.

Additional details regarding this site and planned remedial actions are available from Mark Kram (see "Points of Contact").

Case Study 2. Navy Fuel Farm Located in Coastal Area
Leaks from UST systems at an active fuel farm have occurred over the past 12 years. In response to the detection of free product in on site subsurface vaults in the 1987 1988 time frame, a pit was dug and 20,000 to 30,000 gallons of free product were pumped from the pit.

Based on observed product thickness in 1990, initial estimates of total product released ranged from 200,000 to 300,000 gallons. However, more recent estimates indicate that the total product volume is less than 100,000 gallons (most likely between 30,000 and 50,000 gallons). The areal extent of contamination is estimated at 50,000 to 8?,500 square feet.

In 1990, the local water board issued a Cleanup and Abatement Order in response to the presence of free product at this site. Project engineers prepared a SOW for a treatability study to identify free product recovery systems best suited to the site. Based on results of the treatability study, product-only recovery systems employing skimmer pumps were selected as the recovery systems of choice. Three recovery wells were installed in addition to one French drain/well combination. Current recovery rates of 100 to 120 gallons per month are being achieved. Recovered product is sent off-site for recycling at a slight charge. The reported quality of product is high indicating that the recovery system is achieving a good level of selectivity between product and water.

Current product thicknesses have been observed ranging from 6 inches to 2.5 feet at the plume center and from 1/16-inch to 4 inches at the plume perimeter.

The cost of this response to date is approximately $300,000.

A complete site characterization is planned for 1993 to delineate the extent of contamination. Results of this characterization will be used to enhance product recovery as well as to select techniques for remediation of the site.

An important lesson learned from this experience is the potential for observed product thickness to be misleading when attempts are made to estimate the total volume of product. When initial estimates were made at this site, observed product thickness was significantly greater than later observations indicated. There are many possible reasons for this fluctuation. Project engineers have proposed that the greater thickness was related to greater hydraulic pressure in the surrounding soil as a result of irrigation in an adjacent agricultural field. When this irrigation was stopped, the thickness was observed to decrease—perhaps in response to reduced hydraulic pressure—allowing for the plume to spread, thereby reducing product thickness.

Because of the various factors affecting product thickness, a direct correlation between product thickness and total product volume cannot be assumed (6).

Additional information regarding this site and ongoing and planned actions are available from Mike Radecki (see "Points of Contact").

Case Study 3. Privately-Owned Gasoline Station Near Urban Drinking Water Source (7,8)
In 1990, a catastrophic release of approximately 1500 gallons of gasoline from an UST occurred. The release occurred near a major city drinking water well field. Upon detection of the release, emergency measures were put into force to control contaminant migration and implement interim remedial action to protect drinking water sources.

Within one day of detection, the UST was removed and wells were drilled. Within one week, product recovery involving air stripping of contaminated ground water was initiated. Within three weeks, six recovery wells were in operation and three air stripping columns were used to treat the contaminated ground water. Less than one year after the release, the ground water was cleaned to nondetectable levels and contaminant migration was controlled eliminating potential threat to the drinking water well field.

At the same time ground water was being treated, field screening was done to better define the extent and degree of contamination. As wells were drilled, soil and water were screened in the field using a portable gas chromatograph. This allowed for the fast, optimum placement of additional recovery wells.

Permits for operation of the air strippers were obtained within a week of their installation. Treatability data required by the state for these permits were obtained on-site using field analytical instrumentation.

This Case Study provides a good illustration of the opportunities and benefits of immediate response and the results of adequate planning.

Further information about this case study may be obtained from the State of Connecticut Department of Environmental Protection, (203) 566-4630.

References

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8. Personal communication with Peter Zack, Senior Environmental Analyst, Connecticut Department of Environmental Protection, 1992.

Points of Contact

Additional information regarding the technical, regulatory, and practical aspects of response to free product discovery may be obtained from:

- Mark Kram, NEESA, Code 112E2, Port Hueneme, CA, (805) 982-2669.
- John Fringer, NEESA, Code 112E4, Port Hueneme, CA, (805) 982-4856.
- John Edkins, NEESA, Code 112E2, Port Hueneme, CA, (805) 982-2631.
- Mike Radecki, SOUTHWESTDIV, San Diego, CA, (619) 532-[illegible]374.
- Tom Schruben, EPA Office of Underground Storage Tanks, Washington, D.C., (703) 308-8875.

L.U.S.T. Line, an EPA-funded newsletter addressing UST issues is available. For information, contact Ellen Frey, Editor, (617) 861-80[illegible].

If you would like to be on the mailing list for additional Tech Data Sheets and/or updates, mail, phone, or fax your request to:

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